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ROSEBUD AND REDLAND MONITORING WELL INSTALLATION REPORT

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Rosebud and Redland Monitoring Well Installation Report

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April 12, 2007

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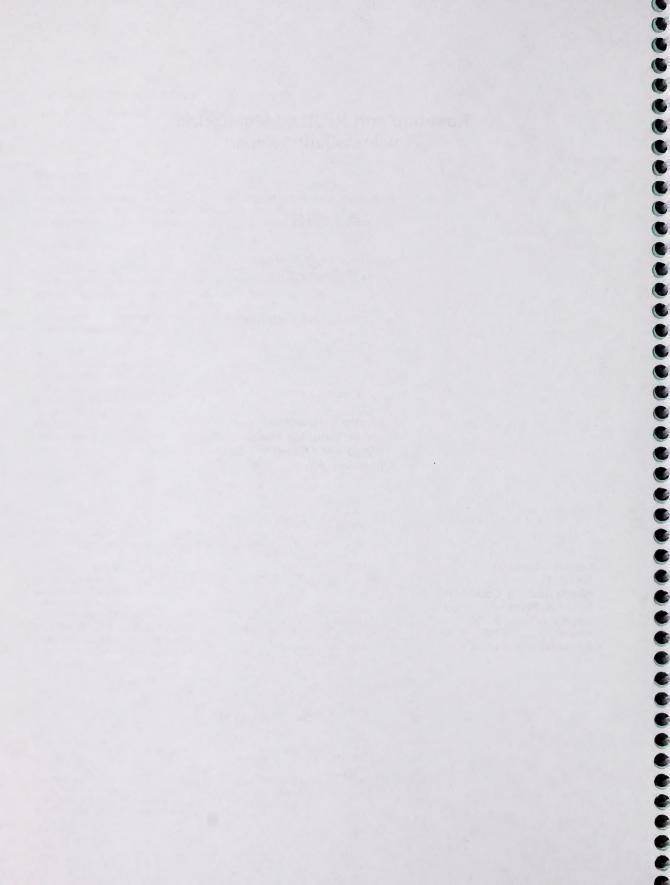


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1 INTRODUCTION

The Alberta Environment (AENV) Groundwater Observation Well Network (GOWN) is a network of groundwater wells that monitor groundwater levels in aquifers across Alberta. Within the network some wells are also monitored for a variety of groundwater quality parameters. The network, starting with three wells in 1957, has grown to over 200 wells for better provincial coverage. Regional AENV staff maintain the wells, download data, take manual readings and archive the data into AENV's GOWN database. The AENV Groundwater Information Centre checks the data and maintains the GOWN database.

The Alberta Research Council (ARC) was contracted by AENV to supervise the drilling and installation of three new wells for the GOWN network. This report details the site selection, drilling and well installation data for these monitoring wells.

2 MONITORING WELL LOCATIONS

Monitoring well locations were determined by several regional and local factors including:

- Expand the GOWN network into areas that were not covered;
- Monitoring wells at one site were to be in a nest (at different completion depths) to be representative of hydrogeologic conditions at the local (shallow well) and intermediate (deeper well) scales;
- Monitoring well at the second site was to be representative of hydrogeological conditions at the local scale;
- Monitoring wells were to be located in order to minimize impact from nearby pumping wells (domestic or industrial water supply wells);
- Monitoring well sites needed to be accessible to the drilling rig and the AENV sampling trailer at all times of the year; and
- Wells were to be located in the valley to minimize drilling footage.

Two monitoring wells (nest) were installed in the town of Rosebud, Alberta, Wheatland County, in the SW-18-27-21-W4M (Figure 1) on County owned land. The deeper well (Rosebud #1) was located at N 51.18095°, W 112.56919° at a surface elevation of 793 m. The shallower well (Rosebud #2) was located at N 51.18092°, W 112.56922° at a surface elevation of 793 m. The wells were completed in the Horseshoe Canyon Formation of the Late Cretaceous Edmonton Group (Borneuf, 1972; Hydrogeological Consultants Ltd., 2003). A site survey plan is presented in Figure 2.

One monitoring well was installed in the town of Redland, Alberta, Wheatland County, in 9-10-27-22-W4M (Figure 1). The well (Redland #1) was located at N 51.292437°, W 113.005688° at a surface elevation of 800.6 m. The wells were completed in the Horseshoe Canyon Formation of the Late Cretaceous Edmonton Group (Borneuf, 1972; Hydrogeological Consultants Ltd., 2003). A site survey plan is presented in Figure 3.

3 MONITORING WELL INSTALLATIONS

The monitoring wells were installed by Gerritsen Drilling Limited of Rockyford Alberta using an Ingersoll Rand TH60 drilling rig (Figure 4). The drilling fluids used included bentonite mud and air in the overburden, and foam and air in the bedrock. Specific details of the drilling operation and the completion details for each well are presented below.

3.1 Rosebud Well #1

Drilling of Rosebud Monitoring Well #1 commenced on March 8, 2007. A test hole was advanced to 18.9 m (62') with a 152 mm (6") tricone drill bit using air to remove cuttings. Cuttings were continuously monitored and logged. Loose sand from the upper section of the hole was noted falling into the hole. The hole was reamed with a 200 mm (7%") bit and a temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 141.4 m (464') using a 130 mm (5%") bit. Cuttings were lifted by air. Cuttings were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and bentonite chips were smeared around the borehole (using the bit and stabilizer) to control the loose sand at 14 to 16 feet. The bentonite chips were unsuccessful at controlling the sands so the hole was reamed with a 219 mm (85%") bit and 8.23 m (27') of 219 mm (85%") steel conductor pipe was inserted to control the sand. The hole was then reamed with a 200 mm (77%") bit to a depth of 137.77 m (452') using air and foam to lift the cuttings. A downhole camera revealed that sand continued to wash down the hole from behind the conductor pipe. An additional 2.59 m (8.5') of 219 mm (85%") steel conductor pipe was welded on and pushed into the ground. This was successful at controlling the sand.

A 141 mm (5.56") steel casing with threaded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 114 mm (4.5") OD schedule 40 PVC liner with environmental threads and orings, along with 12 evenly spaced K-packers were simultaneously lowered and grouted into place (Figure 4) from above the surface to 141.42 m (464'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A.

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.64 m and a total depth of 141.12 m. The well was dry in the completed coal zone and methane gas was present. A compression cap with sampling valve and pressure gauge was fitted to the well and a locking mechanism restricts access to the well.

3.2 Rosebud Well #2

Drilling of Rosebud Monitoring Well #2 commenced on March 22, 2007. A test hole was advanced to 18.9 m (62') with a 200 mm (7%") tricone drill bit using bentonite mud to remove cuttings. A temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 55.47 m (182') using a 130 mm (5%") bit. Cuttings were lifted with air. Cuttings

were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and the hole was then reamed with a 200 mm (71/8") bit to a depth of 53.34 m (175') using bentonite mud to lift the cuttings. A 168 mm (65/8") steel casing with welded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 125 mm (4.94") OD schedule 40 PVC liner with threaded joints, along with 3 evenly spaced K-packers were simultaneously lowered and grouted into place from above the surface to 55.47 m (182'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A. The well was developed with air until the water produced was clear. The apparent well yield was approximately 0.5 Imperial gallons per minute (IGPM).

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.59 m and a total depth of 55.34 m. The apparent static water level in the well was 13.11 m below ground surface. The well was fitted with a locking cap. The well was shock chlorinated at the completion of the project.

3.3 Redland Well

Drilling of Redland Monitoring Well #1 commenced on March 26, 2007. A test hole was advanced to 22.1 m (72.5') with a 200 mm ($7\frac{1}{8}$ ") tricone drill bit using bentonite mud to remove cuttings. A temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 51.51 m (169') using a 130 mm ($5\frac{1}{8}$ ") bit. Cuttings were lifted with air. Cuttings were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and the hole was then reamed with a 200 mm (7%) bit to a depth of 50.29 m (165') using bentonite mud to lift the cuttings. A 168 mm (6%) steel casing with welded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 125 mm (4.94") OD schedule 40 PVC liner with threaded joints, along with 4 evenly spaced K-packers was simultaneously lowered and grouted into place from above the surface to 51.51 m (169'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A. The well was developed with air until the water produced was clear. The apparent well yield was approximately 1 IGPM.

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.60 m and a total depth of 51.44 m. The apparent static water level in the well was 4.76 m below ground surface. The well was fitted with a locking cap. The well was shock chlorinated at the completion of the project.

4 CONCLUSIONS AND RECCOMMENDATIONS

The following key points are summarized for the drilling programs in Rosebud and Redland.

- Exploration drilling in Rosebud encountered an apparently saturated silty sand and sand from about 2 to 5 m.
- Exploration drilling in Rosebud encountered several water bearing coal zones above 55 m. The main water bearing coal zone was encountered from 54.25 to 55.17 m. The well completed in this zone (Rosebud Well #2) yielding approximately 0.5 IGPM. This is consistent with the depth and yield of most local water wells (Alberta Environment Provincial Water Well Data Base, 2004).
- In Rosebud no water was encountered from below about 55 m to the maximum depth drilled (about 141 m). No water was encountered in the screened interval of Rosebud Well #1 but methane gas was encountered.
- Exploration drilling in Redland encountered a fine gravel from about 6.4 to 7.3 m.
- Exploration drilling in Redland encountered a minor water bearing sandstone at approximately 48 m. The main water bearing coal zone was encountered from 50.59 to 51.21 m. The well completed in this zone (Redland Well #1) yielded approximately 1 IGPM. This is consistent with the depth and yield of most local water wells (Alberta Environment Provincial Water Well Data Base 2004).

Based on the drilling and testing program at Rosebud and Redland, the following recommendations are made.

- These monitoring wells should be equipped with an automatic water level monitoring device (such as an In-Situ MiniTROLL) to monitor impacts of stresses on the regional aquifer system by water withdrawals or drought.
- Prior to geochemical sampling of Rosebud Well #2 and Redland Well #1, the wells should undergo a pumping test to determine aquifer hydraulic properties. This will also remove residual chlorine resulting from the shock chlorination of the wells.
- Rosebud Well #1 gas should be sampled and analysed for composition (GC analysis) and carbon and hydrogen isotopes.
- The Rosebud Well #1 will need to be licensed by the Alberta Energy and Utilities Board (AEUB). This process has been initiated by AENV.

This work was carried out in accordance with accepted hydrogeological and groundwater engineering practices.

Respectfully submitted,

Alberta Research Council



Alexander Blyth, Ph.D., P.Geol. Research Hydrogeologist

5 REFERENCES

Alberta Environment Provincial Water Well Data Base (2004).

- Borneuf, D., 1972. Hydrology of the Drumheller Area, Alberta. Alberta Research Council Report 72-1.
- Hydrogeological Consultants Ltd., 2003. Wheatland County Part of the South Saskatchewan Basin, Tp 021 to 028, R 17 to 26, W4M. PFRA Regional Groundwater Assessment Report.

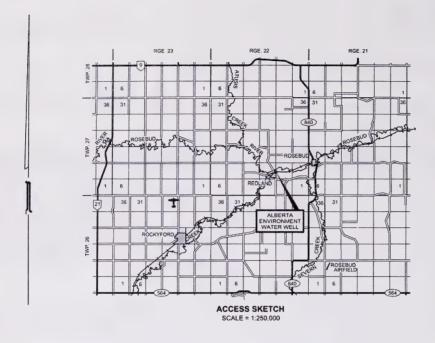


Figure 1. General site location map.

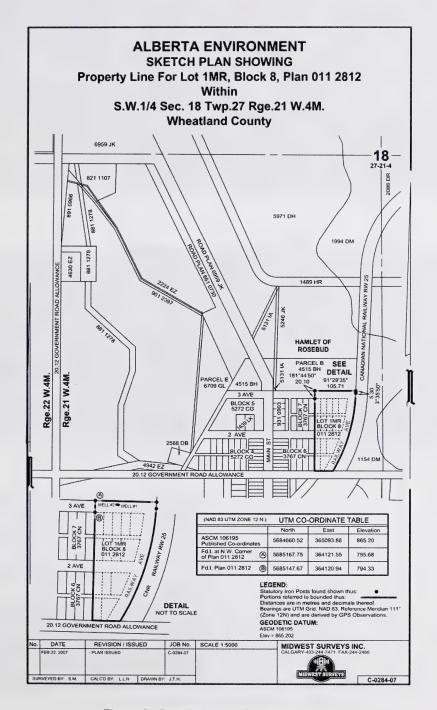


Figure 2. Detailed map of Rosebud area.

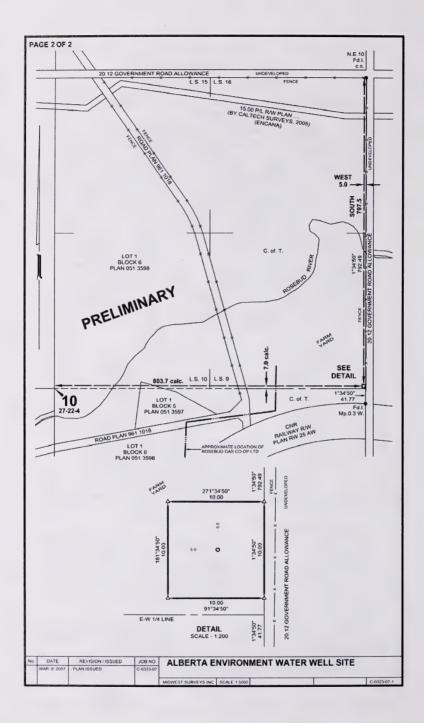


Figure 3. Detailed map of Redland area.



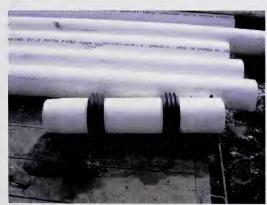
Ingersoll-Rand TH60 Drilling Rig

Tricone bit and Stabilizer



Wildon M15 Diaphragm Grout Pump

Installing and Grouting Liner



K-Packer on Casing Liner

Figure 4. Photographs



Ingersoll-Rand TH60 Drilling Rig

Tricone bit and Stabilizer



Wildon M15 Diaphragm Grout Pump

Installing and Grouting Liner



K-Packer on Casing Liner

Figure 4. Photographs

Appendix A Lithological Description and Well Completion Details

Rosebud Well #1 SW-18-27-21 W4 N 51.18095°, W 112.5619, 793 m

Depth from Lithology Description Ground (feet) Clavey Silt, med, brown Silty Clay, med. brown Clayey Silt, med. brown 5 6.5 Sandy Silt, lt. brown 6.5 Silty Sand, lt. brown, occasional pebble 14 16 16 Sand, medium, occasional pebble, poorly sorted, subrounded Clavey Silt, sand from above mixed with returns 32 32 Silty Clay, med. grey 62 62 66 66 Siltstone, med. grey, highly weathered, soft Siltstone, med. grey 80 80 82 Sandstone, It. Grey, fine grained Siltstone, med. grey Sandstone, It. grey, soft. Water ~0.5 IGPM 82 97 97 99 99 112 Shale, black, silty in places Sandstone, It. grey, soft, fine grained Siltstone, med. grey 112 117 117 120 124 132 Sandstone, It. grey, hard, fine grained Shale, black, occasional It brown surfaces 120 124 132 133 COAL (Weaver coal). Water ~1 IGPM 133 145 145 147 Shale, black Sandstone, It. Grey, fine grained 147 148 COAL (Weaver coal). Water minor 155 148 Shale, med. brown, silty 155 158 Sandstone, It. grey, hard, fine grained 159.5 165 158 COAL (Weaver coal). Water minor Siltstone, med. grey Sandstone, lt. grey, fine grained 159.5 167 167 170 Shale, black Sandstone, lt. grey, hard, fine grained 170 178 181 COAL (Weaver coal). Water ~1.5 IGPM 181 190 Shale black 190 193 Sandstone, It. grey, fine grained 193 209 216 Shale, black, occasional it brown, hard siliceous layers Sandstone, lt. grey, fine grained 209 Shale, black. Bentonitic clay layer at 219' 235 236 Sandstone, It. grey, very hard, siliceous, fine grained Shale, black 236 258 263 Sandstone, It. grey, hard, fine grained Siltstone, med. grey. Minor coal at 278' COAL (Garden Plains) 263 310 311 310 311 314 314 Shale, black 317 Sandstone, It. grey, fine grained 317 328 Shale, black, minor siliceous layer, minor coal at 326' 328 329 329 330 Sandstone, It. grey, hard, fine grained Shale, black 330 333 Sandstone, grey, hard, fine grained 333 334 Shale, black 334 335 Sandstone, grey, hard, fine grained Siltstone, med. grey
Sandstone, It. grey, fine grained. Siliceous layer at 338' 335 337 337 339 342 Shale, black 339 COAL (Garden Plains) Shale, black. Sandy at 351' 342 343 343 354 354 357 Sandstone, It. grey, hard, fine grained 357 358 COAL (Garden Plains) 358 359 Sandstone, It. grey, fine grained 359 368 Siltstone, med. grey Sandstone, It. grey, fine grained, silty Siltstone, med. grey 368 370 370 372 372 373 373 374.5 Sandstone, lt. grey, fine grained Siltstone, med. grey. Siliceous layer at 374' Shale, black. Siliceous layer at 395' 374.5 400 400 406 Sandstone, lt. grey, hard, fine grained 406 407 Siltstone, med. grey 407 409 409 Sandstone, lt. grey, hard, fine grained 425 Siltstone, med. grey. Sandy from 424-425" 432 425 434 437 432 COAL (Garden Plains coal) 434 Siltstone, med. grey 437 443 Sandstone, It. grey, fine grained. Siliceous layer at 439' and 442' 443 454 Siltstone, med. grey COAL (Garden Plains) 454 460 460 461 Siltstone, med. grey COAL (Garden Plains), shalev lenses 461 463 Siltstone, med. grey End of hole

Completion Details

Borehole diameter 7 7/8" from surface to 450 ' (137.16 m) Borehole diameter 5 15/16" from 450-464' (137.16 to 141.42 m)

Steel conductor pipe $8\,5/8^\circ$ from surface to 35.5° ($10.82\,\mathrm{m}$) Steel Casing diameter $5\,9/16^\circ$ (10), threaded joints, from -2.1 - 452° ($-0.64\,\mathrm{m}$ to $137.77\,\mathrm{m}$) Liner diameter 4.5° (00), environmental threads with o-rings, from -2.1 to 464° ($-0.64\,\mathrm{to}$ $141.42\,\mathrm{m}$) Screened section of liner, $20\,\mathrm{siot}$ machined

Bentonite grout from surface to 452' (137.77 m) outside steel casing Bentonite grout from surface to 452' (137.77 m) between steel casing and liner

12 evenly spaced K-Packers

Completed Well Measurements
Depth of well 464.97* (141.76 m) to Top of Casing
Casing Stick up 2.10* (0.64 m)
Total depth of well 463* (141.12 m) below ground surface
Static Water Level – no water. 54 PSI pressure

Rose	bud Drilling			Rosebud/	Redland				BORE	HOLE:	Rosebu	d Well 1
	ALLED BY: Alberta Res					SITE:			8789009			
DRIL	L TYPE: Air Rotary			North: 51.		West:	112.569			ATION:	2601.70	06 (ftasl)
FILL	TYPE: Slough	Bentonite	ZZ		Backfill	Sar	nd	Pelton		Open Hole	Unknow	n
SAMI	PLE TYPE:	Shelby Tube	∭ No	Recovery	Split Spoon	Dis	sturbed	Dynai Dynai	mic Cone	Core	Grab Sa	
D e p t h	LITHOLO	GIC DESC	CRIF	PTION					Casing diam	LATION	N	E l e v (ftasl)
- 1.0 - 2.0	Clayey Silt											2602.0 - 2603.0 - 2604.0
- 2.0 - 3.0 - 4.0	Silty Clay											- 2605.0 - 2606.0
- 5.0 - 6.0 - 7.0	Clayey Silt											2607.0 2608.0
- 7.0 - 8.0 - 9.0	Sandy Silt											2609.0 - 2610.0 - 2611.0
- 10.0 - 11.0 - 12.0 - 13.0 - 14.0	Silty Sand - Occasiona	ıl pebble				ı						2612.0 2613.0 2614.0 2615.0
- 15.0 - 16.0 - 17.0	Sand - Medium, occas sorted, subrounded											2616.0 2617.0 2618.0 2619.0 2620.0
- 18.0 - 19.0 - 20.0 - 21.0 - 22.0 - 23.0 - 24.0 - 25.0 - 26.0 - 27.0 - 28.0 - 29.0 - 30.0 - 31.0	Clayey Silt - Sand fror returns	n above mixed v	vith		ı							2621.0 2622.0 2623.0 2624.0 2625.0 2626.0 2627.0 2628.0 2630.0 2631.0 2632.0 2632.0 2632.0 2633.0
32.0 33.0 35.0 35.0 35.0 37.0 38.0 37.0 39.0 40.0 42.0 44.0 45.0 44.0 45.0 45.0 50.0 51.0 55.0 56.0 55.0 56.0 56.0 61.0 61.0 61.0	Silty Clay											263-10 263-0 263-0 263-0 263-0 2641-0 2641-0 2645-0 2645-0 2645-0 2645-0 2650-0 2660-0
- 63.0 - 64.0 - 65.0	Siltstone - Highly wea	thered, soft										2665.0 - 2666.0 - 2667.0 - 2668.0
- 66.0 - 67.0 - 68.0 - 69.0 - 70.0 - 71.0 - 72.0 - 73.0 - 74.0 - 75.0 - 76.0 - 77.0 - 78.0 - 78.0 - 80.0	Siltstone											2669.0 2670.0 2671.0 2671.0 2673.0 2674.0 2675.0 2676.0 2677.0 2680.0 2681.0 2682.0
- 81.01 - 82.0	Sandstone - Fine grain	ned										2683.0 2684.0
- 83.0 - 84.0	Siltstone											2685.0 2686.0
	Alberta Research Cour	ncil			TWDE		Alec Blyt		COME	COMPLI		54.00 (ft)
			Date pr	inted: 12-Apr-200	D7 TYPE:	Gas Moi	nitoring \	well		COMPLI	ETED:	

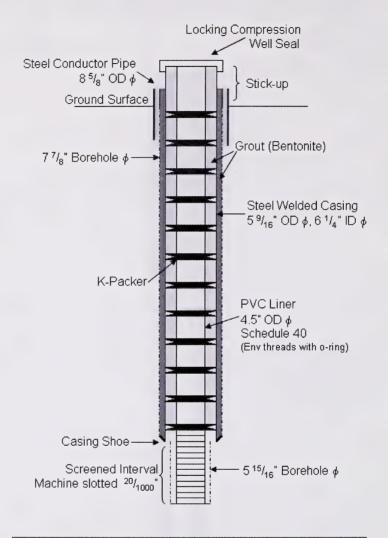
Rosebud Drilling Rosebud/Ro									BOREF	IOLE:	Rose	ebud Well 1	
	ALLED BY: Alberta Res	earch Council			-				SITE:			8789009	
DRIL	L TYPE: Air Rotary			North: 51	1.181	W	est: 112.569)	ELEVA	TION:	260	1.706 (ftasl)	
FILL	TYPE: Slough	Bentonite	Gr	rout	Backfi	1	Sand	Pelton	ite	Open Hole	∭ Unk	nown	
SAM	PLE TYPE:	Shelby Tube	M N	o Recovery	Split S	poon	Disturbed	Dynar Dynar	nic Cone	Core	Gra	b Sample	
D e p t h	LITHOLO	GIC DESC	CRIF	PTION	N				WEI TALI Casing diam.	ATION = 0.464 ft		E e v	
- 86.0 - 87.0 - 88.0 - 89.0 - 91.0 - 92.0 - 93.0 - 95.0 - 96.0 - 97.0 - 98.0 - 99.0 - 100 - 101 - 102 - 103 - 104 - 105	Sandstone - Soft, water Shale - Silty in places	~0.5 IGPM										2687.0 2689.0 2689.0 2690.0 2691.0 2691.0 2692.0 2693.0 2693.0 2693.0 2693.0 2693.0 2693.0 2693.0 2693.0 2693.0 2693.0 2703.0 2703.0 2704.0 2702.0 2703.0 2704.0 2705.0 2706.0 2706.0 2706.0 2707.0 2708.0	
- 106 - 107 - 108 - 109 - 110 - 111 - 112 - 113 - 114 - 115 - 116 - 117	Sandstone - Soft, fine g	grained										2708 2708 2709 2710 2711 2711 2712 2713 2714 2715 2716 2717 2717 2717	
- 118 - 119	Siltstone											2720 - 2721	
- 120 - 121 - 122 - 123	Sandstone - Hard, fine	grained										2722 2723 2724 2725	
- 123 - 124 - 125 - 126 - 127 - 128 - 129 - 130 - 131	Shale - Occasional ligh	t brown surface	s									2726 2727 2728 2728 2729 2730 2731 2732 2732 2733	
- 132 - 133 - 134	Coal - WEAVER COA	L, water ~1 IGI	PM									2734 2735 2736	
- 134 - 135 - 136 - 137 - 138 - 139 - 140 - 141 - 142 - 143 - 143	Shale											2737 111 2738 12749 12741 12742 12743 12744 12744 12745 12745 12746	
145 146 147	Sandstone - Fine grain	ed										- 2747 - 2748 - 2749	
- 148 - 149	Coal - WEAVER COA	L, water minor			·							2749 - 2750 - 2751	
- 147 - 148 - 149 - 150 - 151 - 152 - 153 - 154 - 155 - 156 - 157 - 158 - 159 - 160 - 161	Shale - Silty											2752 2753 2754 2755 2755 2756	
- 156 - 157 - 158	Sandstone - Hard, fine	grained			,							2757 2758 2759 2760	
- 159 - 160	Coal - WEAVER COA	L, water minor						,				2761 2762	
- 162 - 163 - 164 - 165 - 166	Siltstone Sandstone - Fine grain	ed										2763 2764 2765 2766 2767 2768	
- 167 168 169	Shale											2769 2770	
109	Alberta Research Coun	cil			LO	GGED F	BY: Alec Bly	/th	COMP	LETION DE	PTH:	464.00 (ft)	
	Anocha Research Coun	· · ·	Date pr	rinted: 12-Apr-2			Monitoring			COMPLE			

Rose	/Redlar	nd				BORE	HOLE:	Rose	bud Well 1				
INSTALLED BY: Alberta Research Council										SITE:			8789009
DRIL	L TYPE: Air Rotary			North: 51			We	st: 112.569			ATION:	2601	.706 (ftasl)
FILL	TYPE: Slough	Bentonite	Gro		Bac			Sand	Pelton		Open Hole	Unkn	own
SAM	PLE TYPE:	Shelby Tube	No.	Recovery	 Sp	lit Spoon		Disturbed	Dyna:	mic Cone	Core	Grab	Sample
D e p t h	LITHOLO	OGIC DESC	CRIP	TION	1					Casing diam	LATION		E l e v (ftasl)
	Sandstone - Hard, fin Coal - WEAVER CO Shale Sandstone - Fine grai Shale - Ocassional lig siliceous layers	AL, water ~1.5 IO	GPM										## 2772 ## 2773 ## 2774 ## 2774 ## 2776 ## 277
- 207 - 208 - 209 - 210 - 211 - 212 - 213 - 214 - 215 - 216	Sandstone - Fine grai												2809 2810 2810 2811 2812 2812 2813 2814 2815 2816 2817 2818
- 217 - 218 - 219 - 220 - 221 - 222 - 223 - 224 - 225 - 226 - 227 - 228 - 229 - 230 - 231 - 232 - 233 - 234	Shale - Bentonitic cla	y layer at 219'											= 2819 = 2820 = 2821 = 2822 = 2823 = 2824 = 2825 = 2826 = 2826 = 2826 = 2826 = 2826 = 2826 = 2831 =
228	Sandstone - Very har grained Shale	d, siliceous, fine											2837 2838 2839 2840 2841 2842 2843 2844 2845 2846 2846 2847 2848 2849 2849 2859 2859 2859 2859 2859 2859 2859 285
	Alberta Research Cou	incil	Date print	ted: 12-Apr-200				Y: Alec BlyMonitoring		COME	COMPLE		464.00 (ft)

Rose	ebud Drilling			Rosebuc	d/Redla	nd				BORE	EHOLE:	Ro	sebud Well 1	
	'ALLED BY: Alberta Res	earch Council								SITE:			8789009	
DRII	L TYPE: Air Rotary			North: 5			Wes	st: 112.569		ELEV	'ATION:	26	01.706 (ftasl)	
FILL	TYPE: Slough	Bentonite	\mathbb{Z}_{0}	Grout	Ва			Sand	Pelton	,	Open Hole	∭ Ur	ıknown	
SAM	PLE TYPE:	Shelby Tube		No Recovery	/ ⋙ S _I	olit Spoon		Disturbed	Dynai Dynai	nic Cone	Core	G	ab Sample	
D e p t h	LITHOLO	GIC DESC	CRI	PTIO	N					TAL Casing diar	ELL LATION n. = 0.464 ft am. = 0.654 ft	I	E 1 e v	
(ft) - 256 - 257 - 258 - 259 - 260 - 261 - 262	Sandstone - Hard, fine	grained							Б	orenoie dia	iii. = 0.054 ii		(ftasl) - 2857 - 2858 - 2859 - 2860 - 2861 - 2862 - 2863 - 2863	
- 263 - 264 - 265 - 266 - 267 - 268 - 269 - 270 - 271 - 272 - 273 - 274 - 275 - 276 - 277 - 278 - 278 - 278 - 278 - 281 - 281 - 282 - 283 - 284 - 285 - 286 - 290 - 290 - 291 - 292 - 293 - 294 - 295 - 297 - 298 - 299 - 300 - 303 - 304 - 306 - 307 - 308	Siltstone - Minor coal a	t 278'											## 2865 ## 2866 ## 2866 ## 2866 ## 2867 ## 2869 ## 2870 ## 2871 ## 2873 ## 2873 ## 2873 ## 2873 ## 2873 ## 2873 ## 2873 ## 2875 ## 287	
-309 -310 -311 -312 -313 -314 -315	Coal - GARDEN PLAI												2911 2912 2913 2914 2915 2916	
- 315 - 316 - 317 - 318 - 320 - 321 - 322 - 323 - 324 - 325 - 326 - 327 - 328 - 329 - 331 - 332 - 333 - 334 - 335 - 337 - 337 - 339	Sandstone - Fine graine Shale - Minor siliceous coal at 326'												2017 2018 2018 2021 2021 2021 2022 2023 2024 2025 2024 2027 2028 2029	
- 329 - 339 - 331 - 332 - 333 - 334 - 335 - 336 - 337 - 338 - 338	Sandstone - Hard, fine Shale Sandstone - Hard, fine Shale Sandstone - Hard, fine	grained											2930 2931 2932 2932 2934 2936 2936 2937 2938 2939 2940	
339	Siltstone				Т	LOCCE	D DV	'. Also Di-	th	COM	DI ETION DE	DTII.	464 00 (ft)	
	Alberta Research Counc	il	Date p	orinted: 12-Apr-2				: Alec Bly lonitoring		COMI	COMPLE		464.00 (ft)	

Rose	ebud Drilling		Rosebud	/Redland				BOREI	HOLE:	Roseb	ud Well 1	
INST	'ALLED BY: Alberta Re	search Council							SITE:			8789009
DRIL	L TYPE: Air Rotary			North: 51		We	est: 112.569		ELEVA	ATION:	2601.7	706 (ftasl)
FILL	TYPE: Slough	Bentonite	\mathbb{Z}_{0}	Frout	Backfill		Sand	Peltor		Open Hole	Unkno	wn
SAM	PLE TYPE:	Shelby Tube	<u></u>	No Recovery	Split Spoon	E	Disturbed	Dyna Dyna	mic Cone	Core	Grab S	ample
D e p t h	LITHOLO	GIC DESC	RI	PTION	1				WE TALI Casing diam.	ATION ≈ 0.464 ft		E I e v
(ft) - 341 - 342 - 343 - 344 - 345 - 346 - 347 - 348 - 349 - 350 - 351 - 352 - 358 - 359 - 360 - 361 - 362 - 363 - 364 - 365 - 366 - 367 - 378 - 378 - 378 - 378 - 378 - 378 - 378 - 378 - 379 - 380 - 391 - 392 - 393 - 394 - 395 - 396 - 397 - 398 - 399 - 390 - 391 - 392 - 393 - 394 - 395 - 396 - 397 - 398 - 399 - 390 - 391 - 392 - 393 - 394 - 395 - 396 - 397 - 398 - 399 - 400 - 401 - 402 - 403 - 404 - 405 - 406 - 407 - 408 - 409 - 410 - 411 - 412 - 413 - 414 - 415 - 416 - 417 - 418 - 419 - 420 - 421 - 422 - 423	Coal - GARDEN PLA Shale - Sandy at 351' Sandstone - Hard, fine Coal - GARDEN PLA Sandstone - Fine grain Siltstone Sandstone - Fine grain Siltstone - Siliceous layer Sandstone - Hard, fine Siltstone - Sandstone - Hard, fine Siltstone - Sandstone - Hard, fine Siltstone - Sandstone - Hard, fine	e grained INS ned ned, silty ned yer at 374' at 395'								- WAZP II		(ftasl)
- 424	Alberta Research Cour	ncil	Date p	rinted: 12-Apr-20			Y: Alec Bly Monitoring		COMPI	LETION DE		64.00 (ft)

Rose	ebud Drilling	Rosebud/Red	lland				BORE	HOLE:	Rosebud Well 1		
INST	'ALLED BY: Alberta Resea	rch Council							SITE:		8789009
DRIL	L TYPE: Air Rotary			North: 51.181		We	est: 112.569)	ELEV	ATION:	2601.706 (ftasl)
FILL	TYPE: Slough		a.e.s		Backfill		Sand	Pelto		Open Hole	Unknown
SAM	PLE TYPE:	Shelby Tube	//	o Recovery 🎇	Split Spoon	E	Disturbed	∭ Dyna	mic Cone	Core	Grab Sample
D e p t h	LITHOLOG	SIC DESC	RII	PTION					WE TALI Casing diam. Borehole dian	LATION = 0.464 ft	E ! e v (ftas!)
- 426 - 427 - 428 - 429 - 430 - 431 - 432	Shale										3028 3028 3030 3031 3032 3033 3033
- 433 - 434	Coal - GARDEN PLAIN	S									3035 3036
- 435	Siltstone										3037 3038
- 436 - 437 - 438	Siltstone										3039 3040
- 439 - 440 - 441 - 442	Sandstone - Fine grained layer at 439' and 442'	, siliceous									3041 3042 3043 3044
- 443 - 444 - 445 - 446 - 447 - 448 - 449 - 450 - 451 - 452 - 453	Siltstone										3045 3046 3047 3047 3049 3050 3051 3052 3053 3054 3054 3054
- 454 - 455 - 456 - 457 - 458 - 459	Coal - GARDEN PLAIN	S									3056 3057 3057 3058 3060 3061
- 460 - 461 - 462	Siltstone				_/ =						3063 3064
- 463 - 464	Coal - GARDEN PLAIN	S, shaley lenses	S			1					3065 3066
465 466 467 468 469 470 471 472 473 474 475 476 477 478 480 481 482 483 484 485 486 487 488 489 491 492 493 494 495 496 497 498 499 500 503 504 505 506 507 508	Othe	HOLE AT 464 r wells in nest: l status: Active	1								3007 3007 3009 3009 3009 3009 3009 3007 3007
- 509	Alborto Possessi Gerilli				LOGGE	D RY	: Alec Bly	rth	COMP	LETION DEF	PTH: 464.00 (ft)
	Alberta Research Council Date printed: 12-Apr-2007						Ionitoring		ED:		



Schematic Completion Diagram for Rosebud Monitoring Well #1 (not to scale)

Rosebud Well #2 SW-18-27-21 W4

SW-18-27-21 W4 N 51.18092°, W 112.56922, 793 m

Depth		Lithology Description
0	2	Clayey Silt, med. brown
2	3	Silty Clay, med. brown
3	5	Clayey Silt, med. brown
5	6.5	Sandy Silt, It. brown
6.5	14	Silty Sand, It. brown, occasional pebble
14	15	Sand, medium to coarse grained, poorly sorted, subround
15	17	Silty Sand, It brown, some clay
17	20	Clayey Silt, It. grey, some sand
20	26	Silty Clay, It. grey, with occasional pebble
26	28	Clayey Silt, It. Grey
28	51	Silty Clay, It. grey, with occasional pebble
51	61	Silty Clay, bluish grey
61	67	Siltstone, med. brown, highly weathered, soft
67	83	Siltstone, med. grey
83	86	Sandstone, It. grey, fine grained
86	90	Siltstone, med. grey
90	96	Shale, black
96	99	Siltstone, med. grey
99	99.5	COAL (Carbon Thompson), shaley. Water ~ 0.25 IGPM
99.5	103	Shale, black
103	104	Siltstone, med. grey
104	112	Shale, black
112	118	Sandstone, It. grey, fine grained
118	120	Siltstone, med. grey
120	127	Sandstone, It. grey, fine grained
127	129	Siltstone, med. grey
129	130	Shale, black
130	131.0	Siltstone, med. grey
131.0	132.5	COAL (Weaver). Water ~ 0.5 IGPM
132.5	142	Shale, black
142	145	Sandstone, It. grey, fine grained
145	145.5	Shale, brown
145.5	146	COAL (Weaver). Water minor
146	146.5	Shale, bentonitic
146.5	153	Shale, black
153	161	Sandstone, It. grey, fine grained
161	172	Shale, black
172	176	Sandstone, It. grey, fine grained
176	178	Shale, black
178	181	COAL (Weaver), Water ~0.75 IGPM
181	182	Shale, black
nd of Hole		,

Completion Details

Borehole diameter 7 7/8" from surface to 175 ' (53.34 m) Borehole diameter 5 15/16" from 175-182' (53.34 to 55.47 m)

Steel Casing diameter 6 5/8" (OD), 6 1/4" (ID), welded joints, from -1.94 - 175' (-0.59m to 53.34 m) Liner diameter 4.94" (OD), 4.5" (ID), threaded, from -1.94 - 182' (-0.59m to 55.47 m) Screened section of liner, 20 slot machined, 173-182' (52.73 to 55.47 m)

Bentonite grout from surface to 175' (53.34 m) outside steel casing Bentonite grout from surface to 173' (52.73 m) between steel casing and liner

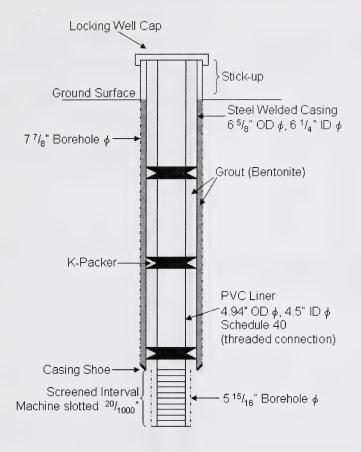
K-Packers at 60, 120 and 172'

Completed Well Measurements
Depth of well 183.45' (55.92 m) to Top of Casing
Casing Stick up 1.94' (0.59 m)
Total depth of well 181.51' (55.34 m) below ground surface
Static Water Level 13.11 m (below ground surface)

Rose	ebud Dril	ling	/Redland	******************************		BOREH	IOLE;	Rosebud W	ell 2		
INST	ALLED	BY: Alberta Research Council						SITE:		878	9009
DRIL	L TYPE	: Air Rotary		North: 51		West: 112.569		ELEVA	TION:	2601.706 (f	tasl)
FILL	TYPE:	Slough Bentonite	\mathbb{Z}°		Backfill	Sand	Pelton		Open Hole	Unknown	
SAM	PLE TY	PE: Shelby Tube	77	No Recovery	Split Spoon	Disturbed	Dynai Dynai	mic Cone	Core	Grab Sample	
D e p t h	L	ITHOLOGIC DESC	CRI	PTION				WEI TALL Casing diam. = Borehole diam.	ATION = 0.552 ft		E 1 e v
- 1.0	Clayey	Silt - medium brown									- 2602.0 - 2603.0
- 2.0 - 3.0	Silty Cl	ay - medium brown									- 2604.0 - 2605.0
4.0 5.0	Clayey	Silt - medium brown									- 2606.0 - 2607.0
6.0 7.0	Sandy S	Silt - light brown	~								- 2608.0 - 2609.0
8.0 9.0	Silty Sa	nd - light brown, occasional								Section 1	- 2610.0 - 2611.0
10.0 11.0	pebble										- 2612.0 - 2613.0
- 12.0 13.0											- 2614.0 - 2615.0
14.0 15.0	Sand - I	nedium to coarse grained, poor	 lv		r						- 2616.0 - 2617.0
16.0 17.0		subrounded	-J . – – – .							100 mg	2618.0 - 2619.0
18.0 19.0	Silty Sa	nd - light brown, some clay								Same Same Same Same Same Same Same Same	- 2620.0 - 2621.0
- 20.0 - 21.0	Clayey	Silt - light gray, some sand									- 2622.0
22.0 23.0		ay - light gray, with occasional									- 2623.0 - 2624.0
24.0 l	pebble									and And And And And And And And And And A	- 2625.0 - 2626.0
25.0 26.0 27.0	Claused	Cilt Light own.									- 2627.0 - 2628.0
- 28.0 - 29.0		Silt - light gray								200 200 200 200 200 200 200 200 200 200	- 2629.0 - 2630.0
- 30.0 - 31.0	pebble	ay - light gray, with occasional									- 2631.0 - 2632.0
- 32.0	1									. Sign	- 2633.0 - 2634.0
- 33.0 - 34.0										200 200 200 200	- 2635.0 - 2636.0
- 35.0 - 36.0											- 2637.0 - 2638.0
- 37.0 - 38.0											- 2639.0 - 2640.0
- 39.0 - 40.0											- 2641.0 - 2642.0
- 41.0 - 42.0										526 526 526 526 526 526	- 2643.0 - 2644.0
43.0 44.0											- 2645.0 - 2646.0
45.0 46.0											- 2647.0 - 2648.0
47.0 48.0											- 2649.0 - 2650.0
- 49.0 - 50.0											- 2651.0 - 2652.0
51.0 52.0	Silty Cl	ay - blueish gray									- 2653.0 - 2654.0
53.0 54.0		6									- 2655.0 - 2656.0
- 54.0 - 55.0 - 56.0 - 57.0 - 58.0 - 59.0 - 60.0 - 61.0 - 62.0											- 2657.0 - 2658.0
- 57.0 - 58.0											- 2659.0 - 2660.0
- 59.0 - 60.0										200 200 200 200 200 200 200 200 200 200	- 2661.0
- 61.0 - 62.0	Silteton	e - medium hrown highly				K-Packer				EII-5	- 2662.0 - 2663.0
- 63.0 64.0	weather	e - medium brown, highly ed, soft								All	- 2664.0 - 2665.0
- 65.0 - 66.0											- 2666.0 - 2667.0
- 67.0 - 68.0	C:1/										- 2668.0 - 2669.0
- 69.0 - 70.0	Siltston	e - medium gray									- 2670.0 - 2671.0
- 71.0 - 72.0											- 2672.0 - 2673.0
- 71.0 - 72.0 - 73.0 - 74.0											- 2674.0 - 2675.0
74.0	L				Locari	D. D.V. Al. Di	1-	COMPL	ETION DEL	OTIL 192.45	- 2676.0 (ft)
	Albert	a Research Council	Data -	rinted: 12-Apr-200		BY: Alec Blyt roundwater Mor			COMPLET		(11)
			Date p	cu. 12-Apr-200	, IIIL. O	. Jana water 14101					

Rose	ebud Drilling	/Redland				BORE	EHOLE:	Rosebud Wel	12			
INST	'ALLED BY: Alberta Researc						SITE:		8789	009		
DRIL	L TYPE: Air Rotary			North: 51	.181	Wes	t: 112.569)	ELEV	ATION:	2601.706 (fta	sl)
FILL	TYPE: Slough	Bentonite	₩ Gi	rout	Backfill		Sand	Pelton	nite	Open Hole	Unknown	-
SAM	PLE TYPE:	Shelby Tube	N	o Recovery	57571		Disturbed	Dynai	mic Cone	Core	Grab Sample	
D e p t h	LITHOLOGI	C DESC	CRII	PTION					TAL Casing diar	LATION n. = 0.552 ft um. = 0.654 ft	(f	E l e v
- 76.0 - 77.0 - 78.0 - 79.0 - 81.0 - 82.0 - 83.0 - 85.0 - 85.0 - 87.0 - 88.0 - 90.0 - 91.0 - 92.0 - 93.0 - 94.0	Sandstone - light gray, fine Siltstone - medium gray Shale - black	grained										2677.0 2678.0 2679.0 2680.0 2681.0 2681.0 2683.0 2684.0 2685.0 2685.0 2685.0 2686.0 2689.0 2690.0 2692.0 2699.0 2699.0
95.0 96.0 97.0 98.0 100 101	Siltstone - medium gray Coal - CARBON THOMPS	SON, shaley	, water	-							वस्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त्रातीयस्त	2697.0 2698.0 2699.0 2700.0 2701 2702 2703
- 102 103	~0.25 IGPM											2704
- 104 - 105	Shale - black											2705 2706
- 106 107 108 109 110 111	Shale - black										HILITATION OF THE STATE OF THE	2707 2708 2709 2710 2711 2712 2713
- 112 - 113 - 114 - 115 - 116 - 117	Sandstone - light gray, fine	grained										2714 2715 2716 2717 2718 2719
118 119	Siltstone - medium gray											2720 2721
- 120 - 121 - 122 - 123 - 124 - 125 - 126	Sandstone - light gray, fine	grained		,		J.	K-Packer				endru uskaruni neriku neriku	2722 2723 2724 2725 2726 2727 2728
- 127 - 128	Siltstone - medium gray										₽ 2	2729 2730
- 129 - 130	Shale - black											2731 2732
- 131 - 132	Siltstone - medium gray					,					<u>-</u> 2	2733 2734
- 133 - 134	Coal - WEAVER, water ~0	0.5 IGPM									₽-2	2735
- 135 - 136 - 137 - 138 - 139 - 140 - 141	Shale - black											2737 2738 2739 2740 2741 2742 2743
142 143 144 145	Sandstone - light gray, fine	grained									=== 2 === 2 === 2	2744 2745 2746
- 146 - 147	Shale - brown										<u></u> 2	747 748
- 148 149	Coal - WEAVER, water m	inor									<u></u>	749 1750
149	Shale - bentonitie					70.5						751
	Shalberty Research Council						Alec Bly	th I		COMPLETE		ft)

Rose	ebud Drilling		Rosebu	d/Redlan	d			BOREF	HOLE:	Rosebud Well 2	
INST	'ALLED BY: Alberta Res	earch Council							SITE:		8789009
DRIL	L TYPE: Air Rotary			North: 5			West: 112.56		ELEVA	TION:	2601.706 (ftasl)
FILL	TYPE: Slough	Bentonite	0		Bac		Sand	Pelto		Open Hole	Unknown
SAM	PLE TYPE:	Shelby Tube	1	No Recover	y 🔆 Spl	it Spoon	Disturbed	Dyna Dyna	mic Cone	Core	Grab Sample
D e p t h	LITHOLO	GIC DESC	CRI	PTIO	N				WEI	ATION = 0.552 ft	E I e v
- 151 - 152 - 153 - 154 - 155 - 156 - 157 - 158 - 159 - 160	Sandstone - light gray,	fine grained									2-275.2
- 161 - 162 - 163 - 164 - 165 - 166 - 167 - 168 - 169 - 170 - 171	Shale - black										Ed. 2763 under 2764 under 2765 under 2765 under 2768 under 2768 under 2769 under 2770 under 2771 under 2772 under 2773 under 2773
172 173 174 175 176	Sandstone - light gray,	fine grained					K-Packer				2774 2775 2776 2777
- 177 178	Shale - black										2778
- 179 - 180 - 181	Coal - WEAVER, water	er ~0.75 IGPM									2780 2781 - 2782
- 182 - 183	Shale - black										2783 2784 2785
		F HOLE AT 18: ell status: Active									### 2787 ### 2789 ### 2789 ### 2790 ### 2790 ### 2792 ### 2793 ### 2795 ### 2795 ### 2795 ### 2795 ### 2796 ### 2796 ### 2797 ### 2796 ### 2797 ### 2796 ### 2797 ### 2801 ### 2803 ### 2804 ### 2805 ### 2806 ### 2807 ### 2808 ### 2809 ### 2812 ### 2815 ### 2815 ### 2815 ### 2816 ### 2820 ### 2822
- 224						OCCE	D. D.V. Alex Di		COMP	ETION DE	- 2826
	Alberta Research Council Date printed: 12-Apr-2007						DBY: Alec Bly roundwater M			COMPLET	



Schematic Completion Diagram for Rosebud Monitoring Well #2 (not to scale)

Redland 9-10-27-22 W4 N 51.292437°, W 113.005688, 800.6 m

Depth from Ground (feet)		Lithology Description
0	1	Silty Loam Top Soil, drk. brown
1	9	Clayey Silt, med. brown
9	21	Clayey Silt, med. brown, some pebbles
21	24	Gravel, fine, poorly sorted, subrounded
24	35	Silty Clay, med. grey, occasional pebble
35	40	Silty Sandy Clay, med. grey, occasional pebble
40	43	Silty Clay, med. grey, bits of coal
43	48	Clay, bluish grey, hard
48	49	Coal, loose (not bedrock)
49	50	Clay, brown
50	64	Clay, bluish grey, hard
64	68	Siltstone, med. grey, highly weathered, soft
68	76	Siltstone, med. grey
76	80	Sandstone, lt. grey, fine grained
80	84	Shale, black
84	84.5	Sandstone, lt. brown, siliceous
84.5	90	Shale, black
90	96	Sandstone, It. grey, fine grained
96	97	Shale, black
97	100	Sandstone, It. grey, fine grained
100	107	Shale, black
107	108	Sandstone, It. grey, fine grained
108	109	Shale, black
109	110	Sandstone, It. grey, fine grained
110	116.0	Shale, black
116.0	118	Sandstone, It. grey, fine grained
118	143	Shale, black
143	143.5	Sandstone, lt. grey, fine grained
143.5	145	Shale, black
145	145.5	Sandstone, It. grey, fine grained
145.5	158	Shale, black, hard siliceous layers at 155' and 158'
158	160	Sandstone, It. grey, fine grained. Water ~0.25 IGPM
160	166	Shale, black
166	168	COAL (Weaver coal). Water ~1.25 IGPM
168	169	Shale, black
End of	hole	

Completion Details

Borehole diameter 7 7/8" from surface to 165 ' (50.29 m) Borehole diameter 5 15/16" from 165-169' (50.92 to 51.51 m)

Steel Casing diameter 6.5/8" (OD), 6.1/4" (ID), welded joints, from -1.97 - 165' (-0.60m to 50.29 m) Liner diameter 4.94" (OD), 4.5" (ID), threaded, from -1.97 - 169' (-0.60m to 51.51 m) Screened section of liner, 20 slot machined, 160-169' (48.77 to 51.51 m)

Bentonite grout from surface to 165' (50.29 m) outside steel casing Bentonite grout from surface to 160' (50.29 m) between steel casing and liner

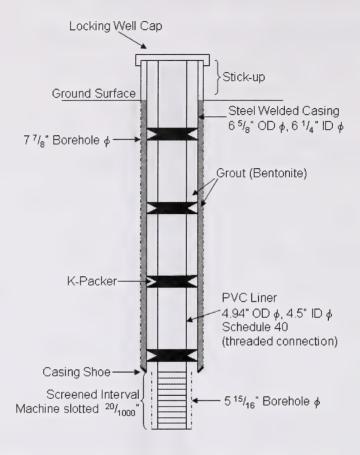
K-Packers at 40, 80, 120 and 160'

Completed Well Measurements
Depth of well 170.69' (52.04 m) to Top of Casing
Casing Stick up 1.97' (0.60 m)
Total depth of well 168.7' (51.44 m) below ground surface
Static Water Level 4.76 m (below ground surface)

Rose	ebud Drilling			Rosebud	/Redland				BOREF	HOLE:	Re	dland Well
INST	'ALLED BY: Alberta Rese	arch Council							SITE:			8789009
DRIL	L TYPE: Air Rotary			North: 51		We	est: 113.005		ELEVA	TION:	2626	.640 (ftasl)
FILL	TYPE: Slough	Bentonite		Grout	Backfill		Sand	Pelton	ite	Open Hole	III Unkn	own
SAM	PLE TYPE:	Shelby Tube		No Recovery	Split Spo	on	Disturbed	∭ Dynar	mic Cone	Core	Grab	Sample
D e p t h	LITHOLOG	GIC DESC	CRI	PTION	1				WEI TALL Casing diam.	ATION = 0.552 ft	1	E 1 e v
- 1.0	Silty Loam Top Soil - d	ark brown								~~~~		2627 0 2628 0
- 2.0 - 3.0 - 4.0 - 5.0 - 6.0 - 7.0 - 8.0	Clayey Silt - medium br											2629.0 2630.0 2631.0 2632.0 2632.0 2632.0 2634.0 2635.0
9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0	Clayey Silt - medium br	own, some peb	bbles									2636.0 2637.0 2639.0 2640.0 2641.0 2641.0 2642.0 2644.0 2644.0 2645.0 2645.0 2646.0
21.0 22.0 23.0 24.0	Gravel - fine, poorly sor	ted, subrounde	d			П						26448.0 2649.0 2651.0
- 25.0 - 26.0 - 27.0 - 28.0 - 29.0 - 30.0 - 31.0 - 32.0 - 33.0 - 34.0 - 35.0	Silty Clay - medium gra pebble	y, occasional										2652.0 ml 2653.0 ml 2654.0 ml 2654.0 ml 2655.0 ml 2655.0 ml 2656.0 ml 2657.0 ml 2658.0 ml 2659.0 ml 2660.0
- 36.0 - 37.0 - 38.0 - 39.0 - 40.0	Silty Sandy Clay - media occassional pebble	ım gray,										2662.0 2663.0 2664.0 2665.0 2666.0
- 41.0 - 42.0 - 43.0	Silty Clay - medium gra	y, bits of coal					K-Packer					2668.0 2669.0
- 44.0 - 45.0 - 46.0 - 47.0 - 48.0	Clay - blueish gray, hard											2670.0 2671.0 2672.0 2673.0 2674.0
- 49.0 - 50.0	Coal - loose (not bedroc	k)										2675.0 2676.0
- 51.0 - 52.0 - 53.0 - 54.0 - 55.0 - 56.0 - 57.0 - 58.0 - 59.0 - 60.0 - 61.0 - 62.0	Clay - brown Clay - blueish gray, hard				J							2677.0 2678.0 2679.0 2681.0 2681.0 2682.0 2683.0 2684.0 2684.0 2684.0 2685.0 2685.0 2686.0 2686.0
- 63.0 - 64.0 - 65.0 - 66.0 - 67.0 - 68.0	Siltstone - medium gray weathered, soft	, highly										2690.0 2691.0 2692.0 2693.0 2694.0
69.0 70.0 71.0 72.0 73.0 74.0	Siltstone - medium gray											2696.0 2697.0 2698.0 2699.0 2700.0
	Alberta Research Counci	1			LOGO	GED BY	: Alec Blyt	h	COMPL	ETION DE	PTH:	170.69 (ft)
	7		Date p	rinted: 12-Apr-20	07 TYPE	: Grour	ndwater Mor	nitoring W	Vell	COMPLE	TED:	

Rose	ebud Drilling			Rosebuc	l/Redlan	ıd				BORE	HOLE:	Redlar	nd Well
	ALLED BY: Alberta Res	earch Council								SITE:	***************************************		789009
DRIL	L TYPE: Air Rotary			North: 5	1.292		We	est: 113.005		ELEVA	ATION:	2626.640	(ftasl)
FILL	TYPE: Slough	Bentonite	W.	Grout	Bac			Sand	Pelton		Open Hole	Unknown	
SAM	PLE TYPE:	Shelby Tube		No Recovery	₩ Spl	it Spoon		Disturbed	Dyna:	mic Cone	Core	Grab Sam	ple
D e p t h	LITHOLO	GIC DESC	CRI	PTION	1					WE TALI Casing diam.	LATION = 0.552 ft		E 1 e v
76.0 77.0 78.0 79.0 80.0	Sandstone - light gray,	fine grained						K-Packer					2702.0 2703.0 2704.0 2705.0 2706.0 2707.0
- 81.0 - 82.0 - 83.0 - 84.0	Shale - black							K-I dekei					2708.0 2709.0 2710.0 2711.0
- 85.0 - 86.0 - 87.0 - 88.0 - 89.0	Shale - black	n, siliceous											2712.0 2713.0 2714.0 2715.0 2716.0
90.0 91.0 92.0 93.0 94.0 95.0 96.0	Sandstone - light gray,	fine grained											2717.0 2718.0 2719.0 2720.0 2721.0
97.0 98.0	Shale - black												2723.0 2724.0 2725.0
99.0 100	Sandstone - light gray,	fine grained											2726
101 102	Shale - black												- 2728 - 2729
- 103 - 104													2730
105 106													2731
	- C 1	C . 1		·									2733
- 108 - 109	Sandstone - light gray,	line grained											2735 2736
110 111	Shale - black	C											2737 2738
112 113	Sandstone - light gray,	fine grained											2739 - 2740
114 115	Shale - black												2741 2742
116 117	Sandstone - light gray,	fine grained											E 2743
118 119		ine granicu											2744 2745
- 120	Shale - black							K-Packer					2746 - 2747
- 121 - 122								IX-1 acker					- 2748 - 2749
123 124													- 2750 - 2751
125 126													E- 2752
— 127													2753 2754
- 128 129													2755 - 2756
- 130 - 131 - 132 - 133 - 134													- 2757
- 132													2758 2759
- 133 - 134													2760 2761
- 135 - 136													2762
<u></u>													- 2763 - 2764
- 138 - 139													2765 2766
- 140 - 141													- 2767
- 142													2768 - 2769
- 143 144	Sandstone - light gray,	fine grained			Γ								2770 2771
145 146	Shale - black				F								2772
138 139 140 141 142 143 144 145 146 147 148		fina grainad											2773 2774
149	Sandstone - light gray, -Shale black, hard silic												2775 2776
	15 Siband kasearch Coun				L	OGGEI	D BY	: Alec Blyt	h	COMP	LETION DEI	PTH: 170	.69 (ft)
			Date	printed: 12-Apr-20	107 T	YPE: C	Grour	ndwater Mo	nitoring V	Vell	COMPLET	TED:	

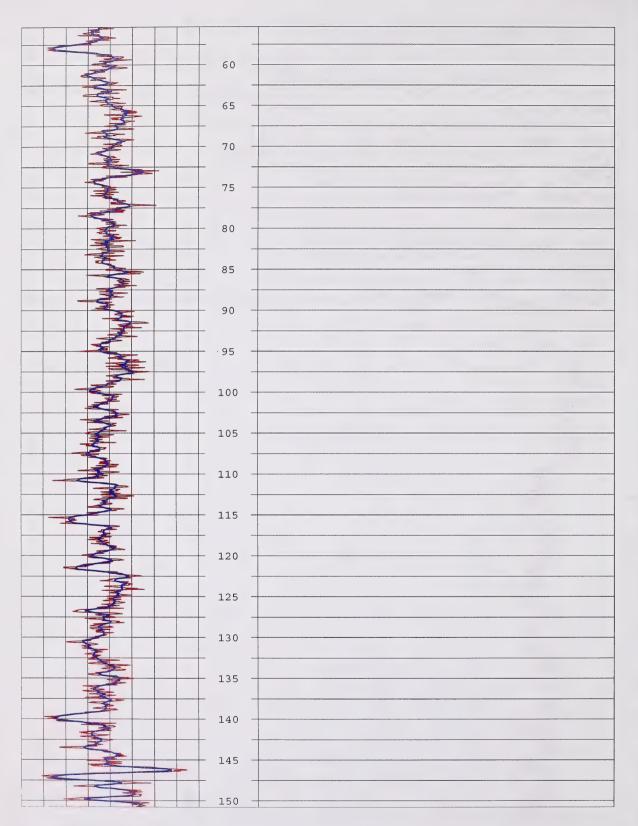
Rose	ebud Drilling			Rosebuc	d/Redland				BORE	HOLE:	Redland Well
INST	INSTALLED BY: Alberta Research Council								SITE:		8789009
DRIL	L TYPE: Air Rotary			North: 5		We	est: 113.005		ELEVA	ATION:	2626.640 (ftasl)
FILL	TYPE: Slough	Bentonite	<u></u>	Grout	Backfill		Sand	Pelton		Open Hole	Unknown
SAM	PLE TYPE:	Shelby Tube		No Recovery	Split Spoon		Disturbed	Dynai	mic Cone	Core	Grab Sample
D e p t h	LITHOLOG	GIC DESC	CRI	PTION	N				WE TALI Casing diam.	ATION = 0.552 ft	E 1 e v
(ft) - 151 - 152 - 153 - 154 - 155 - 156 - 157 - 158 - 159 - 160 - 161 - 162 - 163 - 164 - 165 - 166	Sandstone - light gray, f \water at ~0.25 IGPM Shale - black	ine grained,					K-Packer	L	orenoe viain	00.941	(fta-l)
167 168 169 170	Coal - WEAVER, Water	r ~1.25 IGPM									2793 2794 2795 2796 2796 2797
1711 1712 1713 1714 1715 1716 171		FHOLE AT 17		ft							2799 and 2799 and 2799 and 2800 and 2801 and 2802 and 2803 and 2804 and 2807 and 2808 and 2811 and 2811 and 2811 and 2816 and 2817 and 2818 and 281
					LOCCE	D D3	Z. Aloc Di-st	h	COMPI	ETION DEP	
	Alberta Research Counc	d	Date i	printed: 12-Apr-20			: Alec Blyt ndwater Mor			COMPLET	



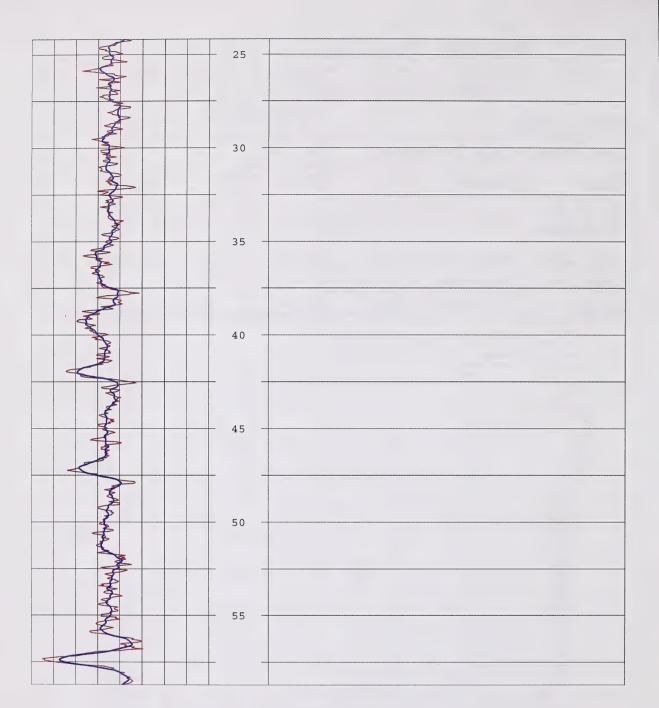
Schematic Completion Diagram for Redland Monitoring Well (not to scale)

Appendix B E-Log

		COMPAN	IY: EN	ZeeTech Ir	nc.
		Location:	Ros	ebud, All	berta
Well	Rosebu	d 1			OTHER SERVICES
				1100	LSD - SW-18-27-21 W4M Elev 795.68
Date		8, 2007 BI		H2O	Lat 51.30158927
Casin		Steel/PVC			Long 112.94917373
File N Depth	ame Driller	Rosebud-1	up.WCL		
	Logger	Mount So	pris MG)	K II	
Logge	d by:	Robert Ky			
Witne	SS: w *.rd Data - G	Cliff Demp	sey, C.7	Tech.	
0 Moving	cps Average (10 pts	160 s) - Gamma	1m:400m		
	cps	100	0 -		
			- 5 -		
			- 10 -		
			- 15 -		
	\$		- 20 -		
		_	- 25		
	1		- 30 -		
			- 35 -		
			- 40 -		
	3		- 45		
	1		- 50 - 		



		COMPAN	Y: ENZee1	ech Ind	Э.					
		Location:	Rosebu	ıd, Alb	erta					
Well	Rosebu	id-2			OTHER SERVICES					
Date		8, 2007 BH	Fluid H2	0	LSD - SW-18-27-21 W4M Elev 795.68 Lat 51.30158927					
Casin	g	Steel/PVC			Long 112.94917373					
File N		Rosebud-2	up.WCL							
Depth	Driller									
Depth	Logger	Mount Sop	oris MGX II							
Logge		Robert Kyl								
Witne	SS: aw *.rd Data - G		sey, C.Tech.							
0	cps	160	1m:175m							
moving	Average (10 pt	s) - Gamma 160								
3			0							
	A A A A A A A A A A A A A A A A A A A		5							
			10							
			15							
	The second second		20							
	-									



		COMP	ANY: EN	ZeeTech	Inc.					
		Location	on: Red	dland, Al	berta					
Well	Redland	11			OTHER SERVICES					
Date	March 2	8, 2007	BH Fluid	H2O	LSD - 09-10-27-22 W4M Elev 800.6					
Casin		Steel/F			Lat 51.292437 Long 113.005688					
File N		Redland	d-1 up.WCL							
	Logger	Mount	Sopris MG	ΧII		13				
Logge	ed by:	Robert	Kyle							
Witne	ss:	Control of the last of the las	empsey, C.	Tech.						
0	aw *.rd File - Ga cps Average (10 pts		Depth 160 1m:200m							
0	cps		160							
	A.A han		0							
1			5							
-	The state of the s		10							
**		:	15							
	The population between		20							
			25							

